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REPORT No. 8.

U. S. DEPARTMENT OF AGRICULTURE.

FIBER INVESTIGATIONS.

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# A REPORT

ON THE

# CULTURE OF HEMP AND JUTE

IN

# THE UNITED STATES,

WITH

STATEMENTS CONCERNING THE PRACTICE IN FOREIGN COUNTRIES, THE PREPARATION OF THE FIBER FOR MARKET, AND REMARKS ON THE MACHINE QUESTION.

BY

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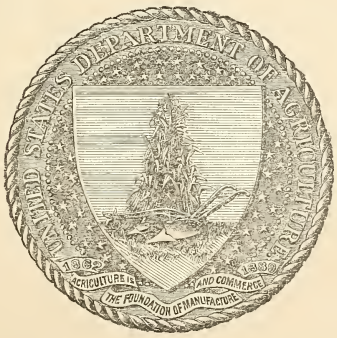


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## LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF FIBER INVESTIGATIONS,
*Washington, D. C., August 1, 1896.*

SIR: I have the honor to transmit herewith the manuscript for Report No. 8 of the Fiber Investigations series. The demand during the past two years for information regarding the best practices for the successful growth of hemp and jute in the United States, as well as the importance of including the accounts of the cultivation of these textiles in the Fiber series of Department publications, make the preparation of this report imperative. Hemp is already produced in limited quantities in portions of our country, but its cultivation should be extended. Jute is not produced within our borders. It is a plant of easy growth, however, and, if the fiber can be produced to compete with the India product, such an industry would bring to the South a portion, at least, of the many millions of dollars now paid out annually for the imported article.

I am, respectfully,

CHAS. RICHARDS DODGE,
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Hon. J. STERLING MORTON,
*Secretary.*

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# CULTIVATION OF HEMP AND JUTE.

## HEMP IN THE UNITED STATES.

### HISTORY OF THE PLANT AND RANGE OF CULTURE.

In the fiber literature of English-speaking countries no name appears more frequently than the word *hemp*, and the name is applied indiscriminately to fibers differing widely from each other. So generally has the term been applied to fibrous substances that often it would be misleading without a prefix—such as Russian hemp, sunn hemp, sisal hemp, and scores of others that relate to entirely distinct kinds of fibers—though the word "hemp" without a prefix is usually understood to mean the fiber from *Cannabis sativa*.

In other languages, likewise, some one name will be found commonly applied to many fibers—as, for example, the word *pita* of Spanish countries, giving us "pita," "pita de corojo," "pita floja," etc., the term often being almost synonymous with hemp.

*Cannabis sativa*, or common hemp, has been so generally cultivated in all parts of the world as a fiber for the manufacture of cloth or cordage that, in a sense, it has become a unit of comparison, and the value of many other fibers is estimated by it. In the long series of experiments by Roxburgh in the early part of the present century we find "Russian hemp" and "best English hemp" taken as standards of comparison in tests showing tensile strength.

While the history of the use of hemp as a fiber does not go back into the ages as far as flax, it is mentioned by Herodotus, and was used by the Scythians at least five hundred years before the Christian era, though some writers attribute to its cultivation an antiquity more remote by a thousand years. It is also referred to in the Hindoo mythology, and was known to the Chinese many centuries before the Christian era.

Some of its native names are as follows: English, *common hemp;* French, *chanvre;* German, *hanf;* Italian, *canapa;* Russian, *konapli;* Arabian and Hindoo, *kanab*, or *kannab;* Bengalese, *ghanga;* Persian, *beng*, or *bung;* Japanese, *asa;* Chinese, *chu ts-as*, etc. From the Arabic is derived the generic name *Cannabis*, and from this, again, it is claimed, the English word "canvas" has been derived.

The plant is an annual shrub belonging to the family Urticaceæ, and while a native of central and western Asia it has been carried by cultivation into nearly all temperate and even tropical countries. It grows

wild luxuriantly throughout Russia and Siberia, in Persia and Caucasus; and in many portions of the United States, where it has escaped from cultivation, it thrives like a native weed in the fence corners and in abandoned situations.

The species is cultivated in central and southern Russia, Hungary, Germany, Italy, and France, in many portions of Asia—India especially, where it thrives at an elevation of 4,000 to 10,000 feet—and in China and Japan. It is also found on both the east and west coasts of tropical Africa, and it has been introduced into Victoria. In the Western Hemisphere it is almost as widely cultivated, as it has been naturalized in portions of South America north of the Rio Janeiro. In our own country it has long been cultivated in Kentucky, Illinois, and Missouri, and more recently the culture has been extended, in a limited way, to contiguous States, including Nebraska and Minnesota, and quite recently to the Mississippi Delta lands. California has also taken up the cultivation of the plant, and it thrives in Canada.

At the present time its growth for commercial fiber is restricted to Europe, Japan, and central United States, while the plant is produced in Eastern countries largely for the sake of the intoxicating drug it yields, known as bhang, ganga, etc.—the "hasheesh" of Eastern literature.

The finest commercial hemp is produced in Italy, that grown in the Romagna being famous. The fiber is soft, creamy, very strong, and is often over 8 feet in length. Some of the dressed samples of hemp from Ferrara, exhibited at the Exposition of 1893 in Chicago, showed the fineness of flax. The hemp of France, cultivated for the most part in Brittany, is also a superior fiber, and resembles the Italian. Only a few tons of Breton hemp come to this market; there is more from Belgium and other countries of northern Europe, but the great bulk of imports is from Italy. According to the figures of the commerce and navigation reports, out of 6,177 tons of hemp and hemp tow imported from all countries in the year 1894–95, 2,575 tons were received from Italy. There is a considerable importation of Russian hemp, some of it doubtless being received indirectly, as the total of direct importation from the Baltic, Black, and White seas is only 476 tons. Russian hemp is low in grade compared with French and Italian, although it is the hemp with which the American product directly competes. Both the Russian and the American are dark in color, some of the latter being a slaty gray, due to the manner of retting.

The most beautiful hemp in the collection of the Department of Agriculture was received from Japan, the fiber being in the form of perfectly flat ribbons, thin as paper, but as smooth and glossy as satin, a light straw color, the frayed ends of these ribbons showing a filament of exceeding fineness, with great strength. This hemp never comes to our market, and is used in its native country largely for the manufacture of cloth. Very little hemp is produced in India for its fiber,

although there was a time when Bombay hemp was superior to the best Russian.

It is not necessary to go into details regarding the varieties of hemp. Several are grown in this country, that cultivated in Kentucky, and having a hollow stem, being the most common. China hemp, with slender stems, growing very erect, has a wide range of culture. Smyrna hemp is adapted to cultivation over a still wider range, and Japanese hemp is beginning to be cultivated, particularly in California, where it reaches a height of 15 feet.[1] Russian and Italian seed have been experimented with, but the former produces a short stalk, while the latter only grows to a medium height. A small quantity of Piedmontese hemp seed from Italy was distributed by the Department in 1893, having been received through the Chicago Exposition, but it failed to germinate, as doubtless the seed was too old.

## STATISTICS OF PRODUCTION IN THE UNITED STATES.

Formerly large areas were devoted to the cultivation of the plant in the United States, and thirty-seven years ago nearly 75,000 tons of hemp was produced, while last year hardly more than 5,000 tons was reported for the whole country. There are several reasons for the decline in production in the United States, but it dates back primarily to the decline in American shipbuilding, to the introduction of the Philippine Island hemp (*Musa textilis*), the manila hemp of commerce, and later to the large importation of jute. Quite recently there has been a further falling off in production, due largely, no doubt, to the decline in prices of the hard cordage fibers, such as sisal and manila hemp, through overproduction, for one of the results of the high prices of these two fibers in 1890–91—at which time the market was manipulated by certain binding twine manufacturers—was to largely increase the foreign supply. In former years Kentucky hemp was not only used for the rigging of vessels and in twines or yarns and bagging, but it was spun and woven into cloth, just as to-day it is manufactured into fabrics in portions of Brittany and in Italy.

In 1890, when the Department became interested in extending the cultivation of hemp, and when the consumption of binding twine amounted to 50,000 tons annually, it was shown that, at the prices then prevailing, if one-half of the binding twine were made of common hemp grown at home, and not from manila or sisal, there would be a clear saving to the consumers of $1,750,000 in a year, with the further advantage that American farmers would produce the raw material. There was a cry that "soft twines" would not work in the self-binders, though the Office of Fiber Investigations was able to show that common hemp twine could be employed quite as satisfactorily as the stiffer twines, and that the prejudice had no substantial foundation.

[1] Probably identical with China hemp.

About that time an effort was made in New York State to revive the "North River" hemp industry, which sixty or seventy years ago was of some importance. Quite a large area was cultivated in the season of 1889, in the neighborhood of Troy and Schaghticoke, through the efforts of Mr. E. A. Hartshorn, of the Cable Flax Mills. The records of twenty crops showed the net proceeds per acre to average $18.22, one farmer having realized $76.48 and another $58.38 per acre, while several crops were practically lost. The industry failed to be reestablished in this region, however, and it has since suffered a great decline in Illinois, where, at that time, considerable low-grade hemp was produced for the manufacture of binding twine.

A summary of hemp production in the United States since 1849 is presented in the following table, from the Eleventh Census:

| States. | 1889. | | | 1879. | 1869. | 1859. | 1849. |
|---|---|---|---|---|---|---|---|
| | Area. | Crop. | Value. | Crop. | Crop. | Crop. | Crop. |
| | *Acres.* | *Long tons.* | *Dollars.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| United States | 25,054 | *a* 11,511 | 1,102,602 | 5,025 | 12,746 | 74,493 | 34,871 |
| California | 22 | 11 | 900 | ..... | 200 | ..... | ..... |
| Illinois | 1,178 | 556 | 44,575 | 61 | 174 | 1,502 | ..... |
| Kansas | 60 | 20 | 1,600 | 72 | 35 | 44 | ..... |
| Kentucky | 23,468 | 10,794 | 1,045,081 | 4,583 | 7,777 | 39,409 | 17,787 |
| Missouri | 79 | 31 | 2,301 | 209 | 2,816 | 19,267 | 16,028 |
| Nebraska | 134 | *a* 54 | 4,350 | ..... | ..... | 9 | ..... |
| New York | 47 | 25 | 2,010 | ..... | 6 | 5 | 4 |
| Ohio | 66 | 20 | 1,785 | ..... | 25 | 1,212 | 150 |
| Not producing in 1889 | ..... | ..... | ..... | 100 | 1,713 | 13,045 | 902 |

*a* Includes 9 short tons; value, $750.

The hemp crop of Kentucky was not over 4,500 tons in 1895, so that the figures for the whole country for that year would doubtless show a decline in production equal to one-half of the quantity reported in the above table for 1889.

## CULTIVATION.

In the past year there has been an increasing demand for information relating to hemp culture, and experiments looking to its production have been carried on in localities where previously its culture was unknown, notably in extreme Southern States, which are large producers of cotton.

### SOIL SELECTION AND FERTILITY.

As in Brittany, so in Kentucky, limestone soils, or the alluvial soils such as are found in the river bottoms, are best adapted to this plant. The culture, therefore, is quite general along the smaller streams of Brittany, where the climate is mild and the atmosphere humid. In Kentucky the best lands only are chosen for hemp, and the most favorable results are obtained where there is an underlying bed of blue limestone. In certain portions of the State, Shelby County, for example, it is claimed that a finer and tougher fiber is produced than in other sections, and this is thought to be due to a mixture in the soil of a whitish, oily clay. As a general rule, however, light or dry soils or heavy, tenacious soils are most unfavorable.

Hemp is not considered a very exhaustive crop. In a former report it was stated by a successful Kentucky grower that virgin soil sown to hemp can be followed with this crop for fifteen to twenty years successively. Sown then to small grain and clover, it can be grown every third year, without fertilizers, almost indefinitely. Spon says: "Over-rich soils produce coarse but strong fiber; light, poor soils, when well manured, will bear the crop for several years in succession." The superb product of Italy is grown upon rich, strong loams, made fine and friable and properly fertilized. In the fiber-producing localities of India, notably in eastern Bengal, the central provinces, and Bombay, moist lands are selected when the soil is "a rich, friable loam."

In France a rotation of crops is practiced, hemp alternating with grain crops, although competent authorities state that it may also be allowed to grow continuously upon the same land, but not without fertilizers. Regarding this mode of cultivation, they consider that it is not contrary to the law of rotation, as by deep plowing and the annual use of an abundance of fertilizers the ground is kept sufficiently enriched for the demands which are made upon it. If the soil is not sufficiently rich in phosphates or the salts of potassium, these are supplied by the use of lime, marl, ground bone, animal charcoal, or ashes mixed with prepared animal compost. Even hemp cake, the leaves of the plant, and the "shive" or "boon" may be returned to the land with benefit. This high fertilizing is necessary, as "the hemp absorbs the equivalent of 1,500 kilos of fertilizers per every hundred kilos of fiber obtained."

In Japan, where "a well-drained, rich, sandy loam" is chosen, the ground is given a heavy dressing of barnyard manure before it is plowed in November. After the soil has been well pulverized and reduced to fine tilth, the seed is drilled and the land given a top dressing composed of one part fish guano, two parts wood ashes, and four parts animal manure. The proportions and the quantities used differ, of course, upon different soils.

Speaking in general terms, Spon's Encyclopædia of Commercial Products lays down the following rule for keeping up the fertility of the soil:

> The quantity of manure necessary will depend on the richness and warmth of the soil and upon the climate. In England 10 to 25 tons of rotten dung to the acre is not considered too much; warm, moist climates require much less. The ash of the plant contains 42.05 per cent of lime, 7.48 of potash, and 3.22 of phosphoric acid. Provided that abundance of chalk, gypsum, or gas lime be supplied, the crop should be much less exhausting than flax.

In New York State, when hemp culture was an industry, barnyard manures or standard fertilizers were used, as it was considered essential to put the soil in good fertility to make a successful crop. In Illinois, with the method of cultivation in vogue, it is not regarded as in any way exhaustive to the soil, though the refuse must be returned if possible. A Kentucky practice is to burn the refuse and spread the ashes over the land.

SOIL PREPARATION.

As in flax culture, a careful and thorough preparation of the seed bed is important, for the finer and more mellow the ground the better will be the fiber. This is better understood in Europe than in America, however, for American hemp is coarse, and its chief use, as a cordage fiber, does not make fineness an essential; in fact, American hemp is more nearly like the hemp of Russia, with which it competes. A successful Kentucky grower states that the practice in the blue-grass region, on sod lands, is to plow about 4 inches deep in the fall or early spring, the seeding being done about corn-planting time. The seed bed is thoroughly prepared, the disk harrow being used, and after the sowing the covering is done by dragging with a harrow the same as for small grains. As the seed is put in broadcast there can be no after cultivation. The date of planting varies according to whether the soil is wet or dry, and may range from the last week in March to the last week in April, or even the 1st of May.

The system of preparing the land pursued in Breton, France, is even more careful. The author did not witness the operation during his visit to this region in 1889, but the Sarthe growers follow this practice:

> The earth is thrown up so as to form two trenches of 0.30 meter (about 1 foot) in width, letting it fall over a strip of ground likewise of 0.30 meter in width, and which is completely covered by the earth thus thrown up. The heat at this season is sufficient to soon destroy the weeds contained in the earth thrown up and overlapped. Ten or fifteen days later a roller is passed over the ground to level it, and a portion of the fertilizer is spread; then about 2½ hectoliters[1] of beans are sown to form a green compost. After this a second plowing is given, but in a reverse manner from the first; that is to say, the strips of ground which had been left at the first plowing are now turned over. The roller is again passed over the rough earth, and draining ditches are made to prevent any moisture from hindering the plowing, which should terminate this series of operations at the end of autumn. This last tilling is done when the beans are 16 to 18 inches high and before the frosts.

The harrow and roller are used to mellow and compact the soil, and small lines of trenches or furrows are dug for drainage purposes, these leading into the transverse ditches. These lines are about 10 feet apart. No further preparation is needed until the time for sowing the seed. Just before this time arrives the ground is worked over to kill the weeds, and is again harrowed. The seed is sown in drills, and covered lightly with a hoe, the soil being pressed down and made compact with this implement. The sowing occurs in the north of France about the last of April.

The drill is likewise used in Illinois, though the most common practice in Kentucky is to sow broadcast, followed by a light harrowing and sometimes by a light drag to level the surface.

A correspondent states that many farmers in Shelby County, Ky., use the ordinary grain drill for broadcast seeding. The rubber pipes

[1] The area was not stated, but it is supposed that this quantity was for a hectare, which would be equivalent to 2¾ bushels of beans to the acre.

are removed from the drill, and a board is attached directly beneath the hopper. The seed falling upon the board is scattered in front of the drill hoes, which do the covering. A light drag passed over the field levels and evens the surface, after which nothing is done until the hemp is ready for the harvest.

### NECESSITY FOR GOOD SEED.

Hemp seed not only loses its germinating power quickly, but it rapidly deteriorates, involving the necessity for frequent renewals and changes, especially when sown thickly. For this reason a French grower thins out the crop along the borders of the field, planting beet root, maize, and similar crops, so that the hemp plants, being isolated, may develop their seed properly. The seed should be well filled, and in color a bright gray, glossy and heavy. Heating injures its germinating power. An English authority says, in regard to selection of seed:

> That from Holland is most esteemed; it ripens soon, and yields abundant and fine crops. Well-grown English seed is, perhaps, equal to it. Seed from the plains of India, though of good outward appearance, yields poor fiber for the first crop or two; but Himalayan seed is inferior to none.

In this country the quantity of seed sown to the acre varies. One large grower says 33 pounds of seed per acre is the proper amount. Another states that 1 to $1\frac{1}{4}$ bushels is his rule. In New York 1 to 3 bushels have been sown (in past time), 1 bushel giving better results than a larger quantity. In Illinois it varies from 1 to $2\frac{1}{2}$ bushels. In France a difference is made regarding the use to which the fiber will be put, a third more seed being sown for spinning fiber than for cordage fiber. On a farm in Sarthe, visited by the writer, a little less than 3 bushels to the acre was the usual quantity sown, but as high as 4 bushels are sown on some farms. On another Sarthe farm the usual custom was to sow 60 liters of seed to 44 ares, 40 ares being equivalent to an acre. This would mean about $1\frac{1}{2}$ bushels to the acre. To state it differently, 250 plants to the meter is considered about the right average when the cordage fiber is desired, and 400 when the fiber is to be used in the manufacture of fabrics. A meter is about $3\frac{3}{8}$ inches over a yard. A Sarthe farmer stated that it was his practice when the ground hardened too rapidly after sowing, and before the plants had started, to strew over the field a quantity of straw. The rake is also used to keep the surface open.

There will be little trouble with weeds if the first crop is well destroyed by the spring plowing, for hemp generally occupies all the ground, giving weeds but little chance to intrude. For this reason the plant is an admirable weed-killer, and in flax-growing countries is sometimes employed as a crop, in rotation, to precede flax, because it puts the soil in good condition. In proof of this, a North River farmer a few years ago made the statement that thistles heretofore had mastered him in a certain field, but after sowing it with hemp not a thistle

survived, and while ridding his land of this pest the hemp yielded him nearly $60 per acre, where previously nothing valuable could be produced. Nevertheless, weeding is practiced in some countries, and in English culture a second weeding is sometimes given.

## HARVESTING AND PREPARING THE FIBER.

### CUTTING AND PULLING.

In Kentucky the hemp stalks are considered ready to cut in one hundred days, or when the first ripe seed is found in the heads. The cutting is usually done with a hooked implement or knife bent at right angles about 24 inches from the hand. In recent years, however, the work is sometimes done by machines adapted to the purpose, and particularly when the stalks are slender.

In France there are two modes of gathering, dependent upon the use to which the fiber will be put. If for cordage, the stalks are cut with a sharp instrument resembling a short scythe, and laid upon the ground in sheaves, where they are left to dry from one to three days. The leaves are then stripped and the stalks removed to the sheds to be assorted, placed in piles horizontally, the lower ends of the stalks being pressed firmly against a wall, so that the inequalities of their length may plainly appear. Upon each pile there is placed close to the wall a weight, to prevent deranging the stems while drawing them out in assorting. This is done by handfuls, first the longest stems, then the medium, and then the short ones. They are bound into sheaves, several of which are put together, forming bundles, each containing stalks of equal length. The top of the sheaves are then cut off, and only the portion preserved that will make good fiber.

When the hemp is grown for use in spinning, that is for fabrics, the stalks are not cut, but are pulled like flax. The operator first removes the leaves by passing his hands from top to bottom of the stalk, it being important to return the leaves to the soil where they were grown. Six to fifteen stalks are pulled at one operation, according to the ease with which they can be drawn out of the ground, and the earth shaken off. These handfuls are made into bundles about 6 inches in diameter; after bundling the roots and tops are cut off by means of an ax and chopping block. The clipped stalks are then made up into larger bundles a foot or more in diameter, and are sent to be retted at once, as it is claimed that the hemp is not so white if it is dried before retting. When the seed is saved the method of procedure is as follows:

In some localities the gathering of the hemp is so managed as to secure the greatest quantity of seed possible of good quality. To this purpose the male stalks are first collected, which ripen six weeks earlier than the female stalks, the latter being given plenty of time to mature and not being gathered until their leaves and stems begin to turn yellow and the seeds to grow dark. They are tied in bunches, and of these there are made large bundles, which are placed upright that the seed may complete its opening. The seeds are extracted by beating the stalks. This manner of operating produces less fiber, and these female plants yield fiber of inferior quality from those selected at the time of maturing of the male plants; but the harvest of

seed compensates for the difference. Taking into account the expense occasioned by the double harvesting and double retting, we find that there is greater advantage in having but one harvest without reference to the seed. Dried in the air the male hemp contains an average of 26 per cent of stripped hemp, and the female plants from 16 to 22 per cent. The stripped hemp dried in the air does not yield more than 60 to 75 per cent of textile fiber, the remainder being foreign matter soluble in leached alkali, so that 100 parts of green hemp do not produce more than 5 to 8 parts of textile fiber.

Spon makes the following general statements regarding the harvesting of a crop of hemp in Europe:

As the fiber afforded by the male plants is tougher and better than that yielded by the female, it is usual to divide the harvest. The males are gathered as soon as they have shed their pollen, about thirteen weeks after the sowing; they are then recognized by their leaves being yellow, stems whitish, and flowers faded. Each is uprooted singly, care being taken not to injure the stem. The ripening of the females, which occurs about a month later, is indicated by similar signs, as well as by the gray tint of the seeds and the opening of the capsules. If the plants are left for the seed to ripen thoroughly, the fiber becomes coarse and woody, and difficult of extraction; hence the full maturity of the seed should not be awaited. Plants which are to give sowing seed must have room to spread and be left to ripen their seed. When it is not intended to preserve the seed (for the sake of its oil), and when the fiber alone is utilized, the plants may be pulled while in flower and without any regard to sex. Under these circumstances mowing would be a much more rapid method of harvesting the crop; yet a prize for a hemp-mowing machine offered some years since by the Hungarian Government did not attract a single competitor. As soon as the plants are pulled they are held by the root and carefully shorn of leaves and flowers, which help to manure the land.

When the stems are stripped they are bound in small bundles and the now dry soil adhering to the roots is knocked off. The stalks forming each bundle should be as nearly as possible of equal length and the roots should be placed even. The bundles are then set on end in stooks like corn. If the crop is to be kept long the bundles are made of larger size and are stacked and thatched. The female plants, after gathering, are allowed to stand in the air for eight to ten days to allow the seed to dry and ripen; heads are then cut off and the seed is thrashed out. Bundles of seeded stems are best conveyed by a rope fastened round under the heads and suspended over the shoulder. The seed remaining after thrashing is combed out, but it is inferior and unfit for sowing. The female plants are generally stacked during the winter and not retted till the spring. The length of time for which the pulled plants should remain in stook to dry before retting is a much debated point. Some authorities declare that one to two days' sun drying is essential, while others state that it is unnecessary and that ripe plants should be retted the moment they are pulled, the retting then reduced from eight days to four.

In Japan hemp is ready for harvesting about one hundred and twenty days after sowing, or about the 20th of July. In harvesting, the plants are pulled, leaves and roots are cut off with a sickle, and the stems sorted into long, medium, and short lengths and bound in bundles. These bundles are steamed for a few minutes in a steaming bath specially constructed, and dried in a sunny situation for three days, when they are fit for keeping, to be manipulated according to the condition of the weather, if favorable or unfavorable. If good, settled weather is anticipated three bundles of the stems above mentioned are made into one bundle, exposed to the sun by

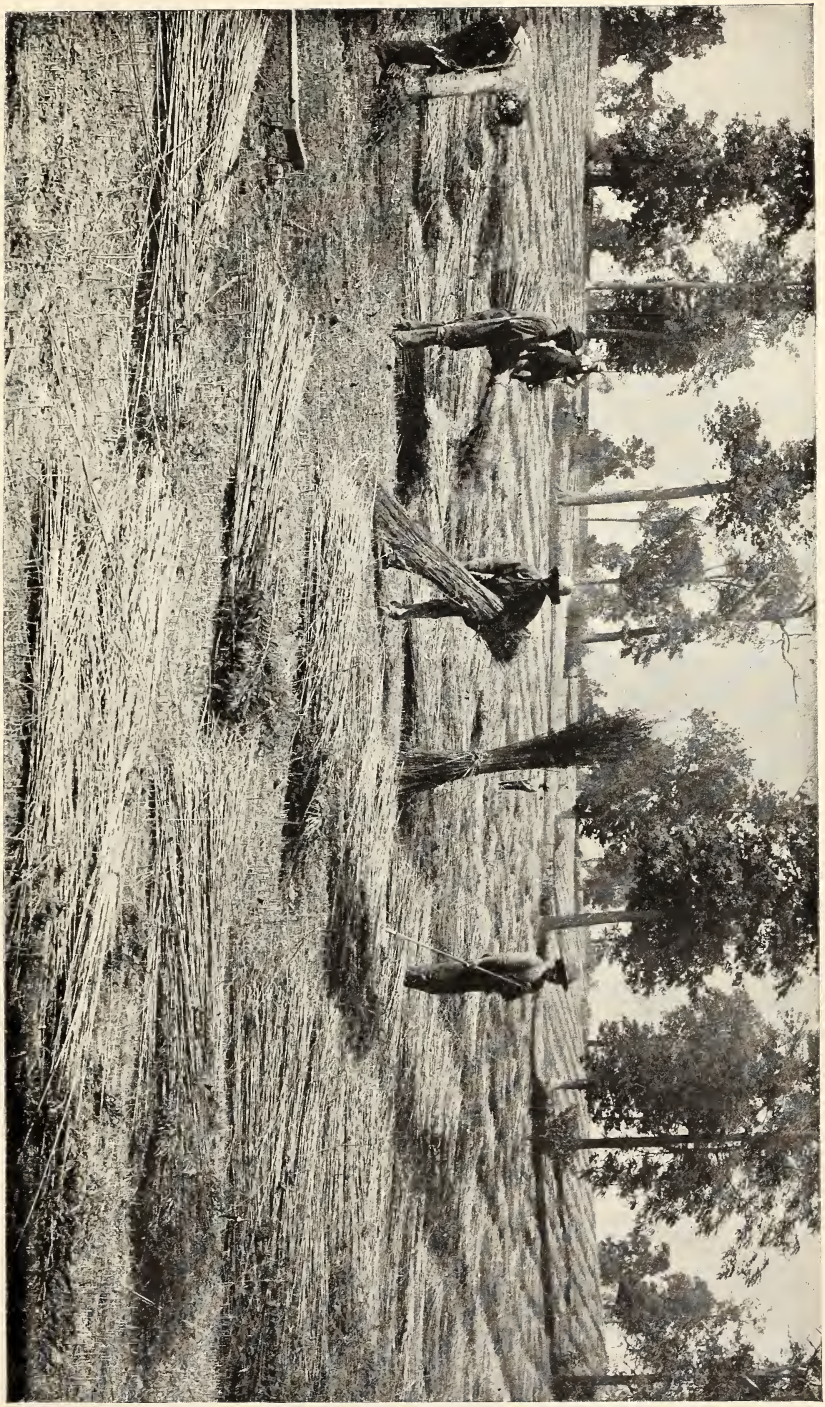
turning upside down once a day for about three days, then dipped into water and exposed again to the sun for a number of days until they are completely dried, when they are kept in a dry place for future work. For preparing the best quality of hemp fiber the drying process takes thirty days, and for second and third qualities fifteen and twenty-five days, respectively, are required. For separating hemp fiber from the stalk the bundles treated as above are immersed in water and moderately fermented by heaping them upon a thick bed of straw or straw mats in a barn specially built for the purpose. The number of hours depends much upon the temperature at the time; in short, the fermentation requires great skill. When the stalks are fermented to a proper degree the fibers are separated by hand and immersed in water, and the outer skin is scraped off also by hand tools specially constructed, and dried in well-ventilated places by hanging the fibers on bamboo, without exposing to the sun.

Hemp is probably never pulled in this country. When the stalks are cut they are laid in rows, even at the butts, and are allowed to remain on the ground not over a week to dry—only long enough, as one correspondent expresses it, to get a rain on the leaves, so that they will drop off readily. When the rain is too long deferred, however, the hemp should be put in shocks or small stacks, having been first made into bundles of convenient size for easy handling.

### RETTING THE CROP.

Hemp is dew retted in this country, that is, spread evenly over the ground to undergo the action of the elements which dissolve or rot out the gums holding the filaments together. (See Pl. I.) Formerly pool or water retting was practiced in a very small way in Kentucky and to a slight extent, later, in Illinois. It has been stated that Henry Clay introduced the practice of water retting into Kentucky, but that it was not extensively followed. Official records show, however, that as early as 1824 an effort was made by "the Commissioners of the Navy" to bring about the employment of water-retted American hemp for the cordage used on war ships. The following is taken from House Doc. No. 22, Twentieth Congress, first session:

> At the instance of a gentleman from Pennsylvania, the Commissioners, in the year 1824, agreed to purchase 2 tons of American water-retted hemp, with a view of having it made into cordage of various sizes, and tested on board of one of our national ships with the best Russian. Under this agreement between 7 and 8 hundredweight only was delivered. This hemp was pronounced by competent judges to be fully equal to the best Russian then in the market, and the growers were accordingly paid the full price of the latter for it.
>
> Cordage made of American hemp, stacked one year, and then dew retted, was fitted on one side of the frigate *Constellation* as main, main top, and fore top sail braces, main-clue garnets, davits, and stern-boat falls. The other side of the ship, in corresponding situations, was fitted with cordage of Russian hemp, and, after being thus worn for nearly a year, it was found, on examination, that the Russian rope, in every instance, after being much worn, looked better, and wore more equally and



SPREADING HEMP IN KENTUCKY.

evenly than the American; that the yarns of the former were rather stronger, and the number of broken yarns not so great as in the American. But although it thus appeared that the Russian rope was rather preferable, both as to strength and durability, yet, in the opinion of the commander, "the difference between them was not so great as to warrant a declaration that the proof was conclusive in favor of the Russian," and he recommended further experiments as necessary to decide the question.

It will be noted that this experiment was with dew-retted hemp. Between 1827 and 1842 the subject of the employment of water-retted American hemp, not only for cordage, but for canvas to be manufactured into sails, was frequently brought before Congress in letters, resolutions, and reports. In a report from the Secretary of the Navy to the United States Senate, dated June 27, 1842 (Twenty-seventh Congress, third session), occurs this paragraph:

From these documents, it appears very clearly that dew-retted hemp will not answer for naval purposes. It is, therefore, absolutely necessary that water retting should be pursued, unless some other process equally good should be discovered. In the present state of our information, we are authorized to assume that the success of the hemp culture in the United States depends exclusively on the proper understanding and judicious prosecution of the process of water retting. * * * There is no reason why all the canvas and cordage used in the American Navy should not, in the course of a few years, be made from American hemp. The first step to be taken is to establish at least two agencies on the western waters to purchase, store, and forward the hemp to the proper points for manufacturing. One of these agencies should be in Missouri and one in Kentucky.

In House Doc. No. 27, Twenty-ninth Congress, first session, dated March 6, 1846, we learn that such agencies were established, with official agents and inspectors, and that the Navy regulations required the use of water-retted hemp in the manufacture of its cordage, but it was afterwards stated that the price of cordage hemp hardly warranted the extra labor and consequent expense.

To return to the subject of dew retting, which is the present practice, the hemp is allowed to remain in stack until November or December, or about two months, when it is spread over the ground until retted. No rule can be given regarding the proper length of time that the hemp should lie, as this varies according to the weather—sudden freezing, followed by thaws, hastening the operation. It is usually allowed to lie until the bast separates readily from the woody portion of the stalk. When there is a large crop, there may be an advantage in spreading the hemp earlier than November, in order that the breaking may be done in the winter months. Winter-retted hemp is brighter, however, than that retted in October. It is usually stacked and spread upon the same ground upon which it is grown, and when sufficiently retted, as can be determined by breaking out a little, it is again put into shocks. If the hemp be dry, the shocks should be tied around the top tightly with a band of hemp to keep out the rain. The shocks are made firm by tying with a band the first armful or two, raising it up, and beating it well against the ground. The remainder of the hemp is

set up around this central support. By flaring at the bottom and tying well, a firm shock can be made that will stand firmly without danger of being blown over by the wind.

Dew retting is practiced to some extent in France, though water retting gives better results. The practice, known as "rouissage," is accomplished both in pools and in running streams. The river retting seems to accomplish better results, although taking a little longer time than the pool retting, the duration of immersion varying from five to eight days. If the weather is cool it retards the operation two or three days longer than if warm. This accounts, too, for the shorter time occupied when the immersion takes place in pools. This work is usually done in the latter part of August. The bundles of hemp are floated in the water, secured if in a running stream, and are covered with boards kept in place by stones or any weight that will keep them under. There appears to be little pool retting in the Sarthe district, although public opinion is generally against river retting on the score of its rendering the waters of the streams foul and detrimental to health, as well as destructive to all animal life with which they would otherwise abound. It is understood that there are very stringent police regulations against the use of streams for this purpose, and as long ago as 1886, in a brochure published by M. Barry, a hemp spinner of Le Mans, attention was called to the desirability of introducing an improved method of retting which would accomplish all the beneficial results of retting in running water artificially, and therefore render unnecessary the polluting of streams. While many attempts have been made to bring about a better system, none have been successful, and, police regulations to the contrary notwithstanding, the best hemp fiber produced in the Sarthe district is still retted in the running streams. Where pool retting is followed, the pools are specially constructed, dug out of the earth to the depth of a yard or more, walled up or the sides made solid, and lined and floored with cement, usually, in order that the water shall remain clean and the hemp retain its color. The stalks are watched very closely after the third or fourth day, the farmer breaking and examining a few at intervals to guard against overretting, which weakens the fiber.

When sufficiently retted, whether the work is done in streams or pools, the hemp bundles are removed from the water, but first agitated to remove all waste matter that may be adhering to the stalks. They are then drained and the bundles, opened at the bottom, are set up in conical sheaves to dry, this operation being accomplished in two or three days. Considerable of the hemp grown, in the Sarthe district at least, is further dried in kilns constructed of brick.

### EXTRACTING THE FIBER.

It is said that nearly 300 patents have been issued in the United States for machines for breaking hemp, many of which have proved absolute failures, while none of them have filled the requirements of

SLAT HANDBRAKE IN OPERATION.

an economically successful hemp-cleaning device, the Kentucky hemp grower of to-day relying upon the rude and clumsy five-slatted hand brake of his grandfather's time, a device similar in all respects to that used for the same purpose at the present day by the hemp farmers of Brittany. (See Pl. II.) The French brake is only a slight advance upon that used in this country, being smaller, composed of both wood and metal, and having seven instead of five slats. (See fig. 1.)

While a less clumsy affair than the American device, yet a French workman can not clean with it more than half the quantity of hemp in a day than an average Kentucky negro operator produces on the American brake. Thirty to thirty-five kilograms of fiber per day is the limit of production for a single brake on a Sarthe farm—equal to 65 or 75 pounds of fiber. It is more carefully prepared, however, being twisted into small "streaks" or loose ropes, a number of these making up a bundle of several kilograms in weight. This is the form in which French hemp goes to market.

In Kentucky breaking is an expensive operation, costing $1 to $1.25

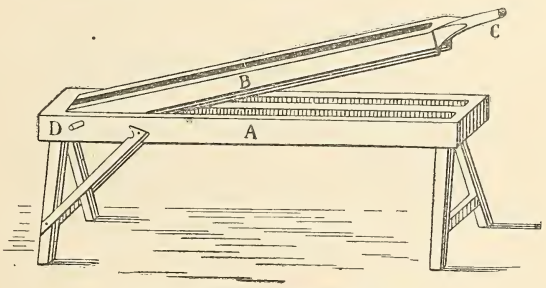



FIG. 1.—French hand hemp brake.

per short hundred pounds of fiber. The work is performed in the winter by negroes, and the best workers will not average more than 150 pounds in a day. In a former report on this subject a homemade machine employed for the purpose in Illinois, was described as a very large brake with fluted rollers, the flutes being from 1½ to 2 inches deep. The cleaning cylinders were 5 feet in diameter of any desired width, with crossbars alternating with loose wings. In the crossbars were pins that acted as combs, these being about three-quarters of an inch long and bent back slightly. Under the cylinders were slats 2 inches apart through which the refuse fell. One cylinder was used close behind the brakes. The other two cylinders had each one pair of rollers in front to hold the fiber while the shive, or waste, was being cleaned out. The fiber was not delivered straight, but it was claimed that twine manufacturers preferred this product to straight Kentucky hemp fiber on account of its superior strength.

A number of patented machines, possessing more or less merit, have been brought to public notice in the past four or five years, several of

which have been examined by the Office of Fiber Investigations. The fact remains, however, that while several of the more recent inventions that have been looked into are "promising," the hemp growers of Kentucky do not consider that a perfectly satisfactory machine is available at the present time.

On another page is given an account of recent operations in hemp culture in the Kern Valley, California. Mr. Sidney E. Meltzer, who is in charge of these experiments, as the agent of the Felix Fremerey Decorticator Company at Bakersfield, informs me that they are using their own machine for stripping the fiber produced by the company. He says:

> The stalks are run rapidly through (the machine) in a green state, and stripped of the ribbons. One machine with twelve knives, cost not exceeding $300, suffices for each 10 acres, and decorticates 200,000 green stalks in ten hours, with 2-horse-power. The ribbons, after decortication, are placed in tanks, ditches, or ponds and retted in two or three days, when the fiber is taken out and dried, baled in a hay press, and is ready for shipment. The advantages claimed for this process of treating hemp are the following: Every particle of fiber is saved, and no tow produced, while the ribbons come from the machine in a perfectly smooth state, straight and untangled, and free from woody matter (shives), with no crosscutting of the fibers. We have a much smaller bulk of merchandise to handle in the retting process, which, consequent on the accessibility of the water to both sides of the ribbons, is accomplished very much quicker than by the methods at present employed elsewhere.

Samples of the product of decortication by this machine have been requested for examination, but none have yet been received.

Regarding ramie and other bast fiber decorticators that have been tested by this Department, and that have been improved since they were given official trials, no authoritative statements can be made without further tests, under Department rules, and any published statements in these reports concerning them must be regarded only as the claims of their inventors or manufacturers. This much may be said, however, that a machine that will economically decorticate ramie will also clean jute or hemp, though a good hemp or jute cleaning device may prove a complete failure in mechanically extracting the fiber of ramie. While the ramie-machine problem has seemed to baffle the inventive genius of two hemispheres for almost a quarter of a century, the writer can not believe that there are insurmountable obstacles in the way of perfecting a device for extracting cheaply the fiber of hemp, particularly as the gums are so easily soluble in water and therefore less tenacious than ramie, and the fiber yields so readily to mechanical manipulation. With this brief reference to the machine question, which interests other countries as well as our own, the account of the extraction of the fiber may be closed. Should any machines of promise be brought to the notice of the Department, the Office of Fiber Investigations will be very glad to give them a public trial and report upon their merits.

With the further preparation of the fiber for manufacture, the farmer has nothing to do, for in this country the rough hemp, as it

comes from the slat brake, is in marketable condition. As illustrating the primitive methods yet in vogue in some foreign hemp-growing sections, there is reproduced here (Fig. 2) the illustration of a French hand-scutching machine with which the fibre extracted with the slat brake is sometimes further prepared. But such an implement would hardly find use in the United States.

## RECENT EXPERIMENTS IN THE SOUTH.

During the past two years the practicability of hemp culture in the South has been discussed, and many letters upon the subject have been received and answered by the Department. Some of these letters have come from persons interested in Florida lands. Inquiries have also come from other Gulf States, but the most interesting correspondence has been with Mr. S. S. Boyce, relating to his own experiments to test

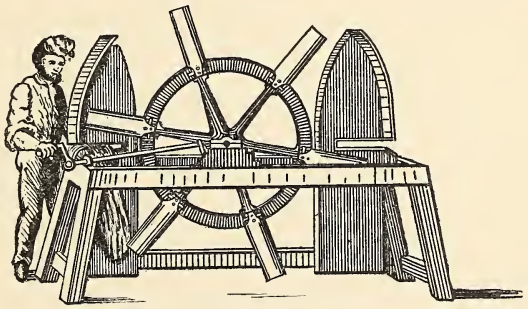


FIG. 2.—French hand hemp-scutching machine.

the practicability of hemp culture in the Yazoo or Mississippi Delta. The work was begun year before last, and was continued through the season of 1895. Mr. Boyce sends statements regarding the Delta hemp as follows:

Some 125 acres were grown at different places to be sure of testing the result under a greater or less rainfall and upon different varieties of soil, as the land differs very materially in different localities on account of the effects of various kinds of deposits from overflows of the Mississippi River; besides this, some lands have been longer in cultivation and have had different practices of restoration.

As found last year, upon a limited scale, fertile land with abundant moisture and tropical heat produce a most prodigious growth, often 15 to 18 feet in height, in sixty to eighty days. If ground is poor the effects of early spring rains is to "pack" and burden it, especially in short periods of drought; not so where soil is fertile, with abundant humus. Hemp sown early grows slower, and is overtaken by later sowings. Upon land in cowpeas, broadcast, the previous year, the hemp grew 12 feet, while where there had been no peas it was but 5 feet tall. Exhausted lands long in cotton gave but 3 to 5 feet, while 2 tons of stable manure to the acre gave 10 feet, and 1,000 pounds of cotton seed to an acre gave hemp 15 feet in height in eighty days.

The question of determining the best methods of restoring these old cotton lands has been but partially settled so far as the phosphates and potashes are concerned.

Contrary to expectations, the fibrous material upon hemp stalks grown here is greater than at the North, giving 26 per cent coarse fiber against 20 per cent in

Illinois. When hemp grows but 5 feet high it is cut with a mowing machine and left on the ground to be retted in the dews and rains, requiring fifteen to thirty days, according to moisture falling upon it; it is then made into tow. When over 5 feet tall it is cut with combined reaper and mower, laid off in bundles and is kept straight, and when retted is broken as line. Water retting has been found practicable, and full results will be reported in due time, as also the success of treating hemp to take the place of the finest flaxes.

## EXPERIMENTS IN CALIFORNIA.

Reference has been made on a previous page to the experiments in hemp culture that are in progress in Kern County, Cal. The company has planted a considerable acreage in Japanese hemp, and at the request of the writer Mr. Meltzer has prepared a brief statement, which is full of interest. He says:

We put out a small quantity early in March of the variety known in Kentucky as Asiatic, here as Japanese hemp. It has been an unusually cold spring with us, and only during the past three or four weeks has the weather been such as to permit of the usual rapid growth. In consequence of this cold weather we delayed putting in our main crop until recently. The first lot is now growing splendidly, being about 8 feet high, and increasing on an average 2 inches daily. It is noticed that after irrigation it does best, and recently it grew nearly 3 inches in twenty-four hours immediately after water had been put upon the land. This goes to show that frequent irrigation is desirable. The soil best adapted to the hemp here is a rich, sandy loam, which does not bake after irrigation, and in experiments made during the past two years the growth was 10 feet in sixty-two days, 15 feet in three months. In preparing the soil, after irrigation, the ground is plowed pretty deep, and immediately harrowed, cross-harrowed if necessary, to work it into fine tilth. The seed is then sown while the soil is moist, in drills 6 inches apart, at depths of 2½ to 3 inches, and the land then rolled or smoothed over to prevent too rapid evaporation and to press the soil upon the seed. In three months' time, when the stalks have attained a height of from 12 to 15 feet, which three or four good irrigations will insure, the crop is cut down with a mower, and the stalks hauled immediately to the decorticating machines.

A particular advantage claimed in growing hemp stalks 15 feet in height is the reduced loss of fiber, as 6 inches or more of the butt of any hemp stalk is useless, and the percentage of wastage on a stalk 6 feet long must be two and a half times larger than on one of 15 feet.

Mr. John Heany, an Illinois hemp grower who contributed statements to a former report of this office, is now located in Butte County, Cal., in the San Joaquin Valley, and is cultivating hemp. Through Mr. Meltzer he writes as follows:

We have now 200 acres hemp growing on river bottom land. This has been an extremely cold year, but the hemp is now growing finely. I have not decided as to how I will ret and handle the crop, but will have a large crop without any doubt. I am getting up the mill and replowing some slough land, and will sow about 50 acres more in a few days. Of the hemp now growing, where our seed was good, there is a thick, good stand, and as even, nice-growing hemp as I ever saw. I walked into it yesterday and in some places it came over my head. My trouble will be in the retting. The land here is not suitable to flood, being too porous and uneven, so I am designing to ret in a slough, where there will be warm water in summer.

The Department will await with interest the report of the present season's operations in California. If a success is made of this culture, it may result in developing an important industry for the State. It is to be hoped that Mr. Heany will treat his crop by the old Eastern method, which will enable comparison being made as to relative cost between the "old-fashioned" system and the newer system in vogue by the Decorticator Company.

Mr. Meltzer communicates the following estimated cost of raising and handling Japanese hemp in Kern County, Cal.:

| | | |
|---|---|---|
| Rent of land per annum, $2.50; water, $1.50 per acre | | $4.00 |
| Plowing and harrowing | $2.00 | |
| Sowing | .30 | |
| Seed, 40 pounds, 8 cents per pound | 3.20 | |
| Irrigating land 4 times, 50 cents | 2.00 | |
| Cutting, per mower, per acre | 1.00 | |
| Hauling to machines, per acre | 10.00 | |
| Decorticating 7,000 pounds fiber, per acre | 10.00 | |
| Retting and drying 7,000 pounds fiber, per acre | 5.00 | |
| Baling 3½ tons, $2, per acre | 7.00 | |
| Hauling to rail 3½ tons, $1, per acre | 3.50 | |
| Freight to St. Quentin Prison Mills, one-third cent per pound, 7,000 pounds | 23.00 | |
| Cost of producing one crop | 67.00 | |
| | 2 | |
| Cost of producing two crops | | 134.00 |
| Total annual expense per acre of two crops | | 138.00 |

Yield of fiber, 7,000 pounds per acre per crop, or two crops, 14,000 pounds per acre. The St. Quentin Mills are using at present a superior quality of jute for which they are paying from 3 to 3½ cents per pound, and offer to pay the same for the coarse hemp produced in Kern County.

## THE USES OF HEMP.

I have alluded to the early use of hemp in Kentucky for the manufacture of coarse-woven goods, such as toweling, and for hempen "linen," or "tow homespun," employed for summer clothing. It is doubtful if American hemp will ever again be used for such purposes, not so much because flax linen is a better product, but because the cheapness of cotton has enabled this fiber to supersede both hemp and flax in common manufactures in the domestic economy. And the same influences have operated against the hemp industry in Breton, France, in which country, not so many years ago, hemp fabrics were almost universally used by the peasant class, even sheeting and shirting goods being made from this textile. In other portions of Europe, likewise, the use of hemp cloth has declined, though in Japan some fine goods are still made from the matchless hemp of that country, while the fine twines, netting yarns, fish lines of Japan, etc., show a finish and strength that are remarkable.

Under the changed conditions, therefore, we may only hope now to employ hemp for the rougher manufactures, and native-grown hemp,

particularly for the cheaper kinds of cordage and twines, although it is fit for bagging.

At the time when the country was producing 75,000 tons of hemp fiber, jute was little known in the American market, and this vast product was utilized in the manufacture of bagging and burlaps, the better qualities being employed for cordage. It is doubtful if hemp fiber can be produced sufficiently cheap to compete with jute butts at 1½ cents per pound, but its larger employment in cordage manufacture would extend its culture, and enable it to recover a part, at least, of the ground it has lost as an American fiber industry. A rough product that could be cheaply produced would be sufficiently good for binding-twine manufacture, and the same quality of fiber could be employed with advantage in the production of the cheaper grades of small cordage that are now made from imported jute, because of its superior strength and less liability to deterioration when stored unused for any length of time. More carefully cultivated and prepared, it would compete with the hemps of other countries in the manufacture of the finer grades of cordage, and with more careful retting, in water, it might be again woven into fabrics.

## AMERICAN JUTE CULTURE.

### INTRODUCTORY.

In the section on hemp, in the first part of this report, it is suggested that as hemp is already established in American agriculture, by extending its culture, it might be made to take the place of jute in many of the coarse jute manufactures now produced in this country, and in a measure regain its lost position. In this connection, I may state that while hemp is the stronger and better fiber, and its culture fully understood, a strong point in the argument for jute cultivation is the fact that the present large demand for India jute assures a ready market for the American product. As many manufacturers are using jute and not hemp, and their machinery is adapted to the softer fiber, they will continue to use jute until satisfied of a positive advantage in employing the other kind. But at the outset it should be understood that the Department urges experiments in the cultivation of both hemp and jute, growing them together in localities where both plants will thrive, in order to ascertain the relative cost of culture of each. The first belongs to more temperate climates, however, while the last is a hot-country product. The employment, in our industrial economy, of both hemp and jute fiber grown on American soil would add greatly to the prosperity of the farmers of both sections of the United States, giving to each a crop with which to replace, in part, the culture of staples which are no longer profitable.

A little more than half a century ago jute was brought into prominence in Europe through the experiments of a Dundee manufacturer, and from that time on the use of the fiber has increased rapidly, until to-day the large consumption of the fiber in all manufacturing countries has given it a very important position in the commercial world.

During the fiscal year 1894–95 over 160,000 tons of jute fiber and jute butts were imported into this country for manufacture, worth nearly $4,500,000, yet jute is the cheapest fiber that comes to our market and, as I have shown, a substance that could be replaced in several important uses by other fibers. It has distinctive qualities, however, and in certain manufactures doubtless could never be superseded by other forms. A chief advantage in its favor is its perfect adaptability to culture in the Southern portions of the United States, which, with the large yield of fiber per acre, emphasizes the possibility of making it a staple production.

As long ago as 1874, after the plant had been successfully introduced upon American soil, India officials wrote thus of its possibilities to American agriculture:

> Competition of a serious kind, however, may be apprehended from North America. In some of the States of the North American Union the jute plant has been very successfully introduced, and has already been found to be more remunerative than

cotton. It is very likely that in a short time the bulk of the requirements of the United States will be supplied by home-grown fiber, and the demand on India will fall off—as regards gunny cloth, it has already fallen off—and in time American jute will be in a position to compete with the Indian produce in the markets of Europe.

With these facts in view, the growth of jute in the United States is worthy of serious consideration, and in order to aid those who may wish to experiment with its culture the following pages have been prepared:

## HISTORY OF THE INDUSTRY.

It has been known and cultivated since remote times in India, particularly in the lower provinces, but its employment as a textile by the nations of the earth is an industry that belongs to the present century.

It was first recognized under a separate head in the custom-house records of the Indian government in 1828, though the fiber had been sent to the European market in trifling quantities during the two or three previous decades.[1] The first exports as jute, in the year named above, amounted to but 18 tons. In 1850–51 the total exports, including jute rope, had reached 30,000 tons and in 1871–72, 310,000 tons. At this time thirty-five districts of India were cultivating 800,000 acres in jute, more than one-half of this area lying in nine districts of northern Bengal.

Up to this date hemp and flax had been used to bale the cotton crop of the United States, and jute as an article of import occupied a very small place. The year 1872, however, saw the native fibers superseded by the India product, particularly in the West, resulting in the almost total destruction of the industries they represented.[2]

As already shown, the present imports of the fiber into this country are enormous, while the exports of raw fiber to all countries from India amounted in 1894–95 to nearly 649,000 tons, the exports of manufactures also showing large figures.

The interest in jute cultivation in this country had its beginning just prior to the time that the fiber began to be largely imported. The Department of Agriculture directed attention to the culture as early as 1869, and in 1869–70 procured from France and India a quantity of the seed for distribution. As a result, hundreds of little cultural experiments were conducted in the South from the Carolinas to Texas, and ample proof was secured that the plant was well adapted to cultivation in the United States. It is unnecessary to give special reference to the favorable testimony published at the time, further than to state that the annual and monthly reports of the Department for five or six years following 1870 contain many articles and communications

[1] In 1793 the East India Company sent to England 100 tons of the fiber under the name "pat." In the warehouse committee's report on this shipment it was stated that "some of the most eminent dealers declare that it is not hemp, but a species of flax, superior in quality to any known to the trade."

[2] See Report No. 1, Fiber Investigations Series, 1890, p. 46.

on the subject, which form an authentic history of the American introduction of the plant and the efforts to establish it in cultivation. That these efforts failed to give practical results is due largely, no doubt, to the absence of adequate machinery with which to prepare the fiber for market, this being the stumbling-block that has prevented success and hindered advancement in new and promising fiber industries even at a later period.

The failure to establish the industry in the early seventies did not prevent further effort, for experimental culture has been continued at intervals down to the present time, the advent of a new invention for stripping the fiber often proving the stimulus.

As to the samples of fiber produced from American-grown jute, they have been proved equal (and in some instances superior) to the India product. Some very excellent samples of the fiber received by the Department from Louisiana in 1873 were pronounced by competent judges to be 50 per cent better than the foreign fiber as imported.

## THE DIFFERENT KINDS OF JUTE.

Jute, or Jews' mallow, belongs to the genus Corchorus, and while some 36 species are distributed over the tropical countries, 8 species are recognized in India, and two of these, *Corchorus capsularis* and *C. olitorius*, which are extensively cultivated, supply the jute of commerce, both species having been introduced into this country. *Corchorus siliquosus* is a well-known tropical American species, said to be indigenous in the West Indies and southward. It is a herbaceous plant only 2 or 3 feet high, its leaves differing from those of the two commercial species "in not having bristles or the two bottom teeth, and there is usually a line of minute hairs along the stem." It is not regarded for its fiber, its only economic uses being the making of besoms by the negroes, while the inhabitants of Panama employ the leaves in an infusion which is a substitute for tea. The Indian species mentioned by Dr. Watt are *C. acutangulus*, fiber coarse; *C. antichorus*, fiber indifferent; *C. fascicularis*, fiber has been employed for ropes; *C. tridens*, locally used for rough cordage; and *C. trilocularis*, said to furnish a fair cordage fiber.

Hem Chunder Kerr, in the Report on the Cultivation of and Trade in Jute in Bengal, 1874, gives the following description of the two cultivated species, *capsularis* and *olitorius:*

The *Corchorus capsularis* is an annual plant, growing from 5 to 10 feet high, with a cylindrical stalk as thick as a man's finger, and seldom branching except near the top. The leaves, which are of a light-green color, are about 4 to 5 inches long by 1½ inches broad toward the base, but tapering upward into a long sharp point with edges cut into saw-like teeth, the two teeth next the stalk being prolonged into bristle-like points. The flowers are small and of a whitish-yellow color, coming out in clusters of two or three together opposite the leaves. The seed pods are short and globular, rough and wrinkled. In technical language it is thus described in botanical works: "Annual, 5 to 10 feet; calyx deeply 5-cleft; petals, 5; leaves alternate,

oblong acuminate, serrated, two lower serratures terminating in narrow filaments; peduncles short; flowers whitish-yellow in clusters opposite the leaves; capsules globose, truncated, wrinkled, and muricated, 5-celled; seeds few in each cell, without transverse partitions; in addition to the 5-partite cells there are other 5-alternating, smaller and empty."

The second species, the *C. olitorius*, is precisely similar to the last in general appearance, shape of leaves, color of flower, and habits of growth; but it differs entirely in the formation of the seed pod, which, in this species, is elongated (about 2 inches long), almost cylindrical, and about the thickness of a quill. The following botanical description of the species is from Major Drury's Useful Plants of India (p. 159): "Annual, 5 to 6 feet crest; leaves alternate, ovate-acuminated, serrated, the two lower serratures terminated by a slender filament; peduncles 1 to 2, flowered; calyx 5-sepalled; petals 5, capsules nearly cylindrical, 10-ribbed, 5-celled, 5-valved; seeds numerous, with nearly perfect transverse septa; flowers small, yellow."

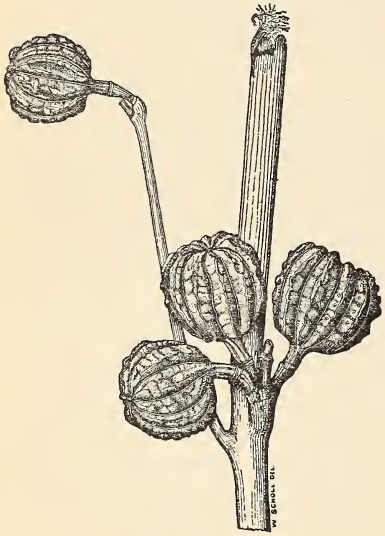


FIG. 3.—Seed vessels of Corchorus capsularis.

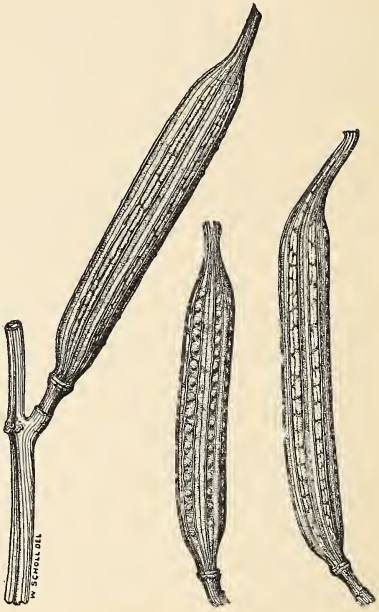


FIG. 4.—Seed vessels of Corchorus olitorius.

The principal points of difference between the two cultivated jute plants, therefore, is in the seed pod, that of *C. capsularis* being "short, globular, rough, and wrinkled," while that of *C. olitorius* "is elongated (about 2 inches), almost cylindrical, and of the thickness of a quill." (See figs. 3 and 4.) Among the many varieties of jute the most common are known by the names (*a*) Uttariya, (*b*) Deswal, (*c*) Desi, (*d*) Deora, (*e*) Narainganji, (*f*) Bakrabadi, (*g*) Bhatial, (*h*) Karimganji, (*i*) Mirganji, (*j*) Jangipuri. These are described by Mr. Kerr as follows:

(*a*) The first variety is by far the best. It is called Uttariya, or northern jute, because it comes from the districts to the north of Serajgungee. The districts are Rungpore, Goalparah Bogra, parts of Mymensing, Cooch Behar, and Julpigoori. This jute recommends itself to the trade by its possessing to the greatest extent those properties which are essentially necessary in fiber intended for spinning,

namely, length, color, and strength. It is sometimes, however, found to be weak, and it is never equal to the Desi and Deswal descriptions in softness. A superior quality of jute is produced, chiefly for domestic use, by the Hajung and Koch tribes of hill people. It comes into the market so late as November.

(*b*) Next in commercial value is the Deswal jute. It goes down fairly with the trade on account of fineness, softness, bright color, and strength. It is stated, however, to have deteriorated to a certain extent within the last two or three years from the inefficient system of drainage in the new fields where it is grown. The fiber has become shorter and more rooty, and lately weaker also. Its name implies that it is the native jute of Serajgungee and its neighborhood. Such of it as is grown on beels is called Bilan, and what is raised in churs is known by the name of Charua; but in Calcutta they pass under the generic name of Deswal. It first comes into the market in Sravana, that is, about the latter end of July or beginning of August. At the present moment fresh consignments of this jute are more in demand than the medium Uttariya fiber.

(*c*) The Desi jute is the produce of Hooghly, Burdwan, Jessore, and 24-Pergunnahs. It is of a long, fine, and soft fiber. If its defects, which are stated to be fuzziness and bad color, were removed, it is believed by men experienced in the trade that its market value would be very much improved.

(*d*) The staple known under the name of Deora comes from Furreedpore and Backergunge. Its name is due to a village in Furreedpore, where formerly there was a large mart. The village has dwindled down to insignificance now, but all the produce of the district, as also of the neighboring district of Backergunge, is known by its name. The bulk of the fiber of this class is strong, coarse, black, and rooty, and much overspread with runners. This fiber is used for the manufacture of rope. Its value would rise if the dealers would refrain from pouring water on the prepared fiber, which they are said to do in order to increase the weight of their consignments. Occasionally small batches of this jute are met with of a very superior quality.

(*e*) The Narainganji jute, which is brought from Aralia, Kurimgunge, and other jute centers, locally called Mokams, of the Naraingunge mart, is mostly the produce of the district of Dacca. It is very good for spinning, being strong, soft, and long; but from some neglect in steeping, the fiber, by the time it reaches Calcutta, changes its original color into a brown or foxy tint, which detracts from its value.

(*f*) The finest description of Dacca jute is the Bakrabadi fiber, which is raised on the churs of the river Megna. It excels particularly in color and softness.

(*g*) The Bhatial jute is also the produce of the district of Dacca, and comes to Calcutta from Naraingunge. It is grown on churs, and is called Bhatial because it is imported to Naraingunge from the south or tidal side (Bhati) of that place. It is very coarse, but strong, and is to a certain extent in demand in the British markets for the manufacture of rope.

(*h*) Karimganji, in the Mymensing district, gives its name to a very fine description of jute which is grown there. It is usually long, very strong, and of good color, partaking to some extent of the nature of the Naraingunge or Dacca jute.

(*i*) The produce of Rungpore, though large, is generally of medium quality, and the worst kind of it comes from Mirgunge, on the Teesta, whence its name Mirganji.

(*j*) The produce of a portion of the Pubna district is known by the name of Jangipuri, so called from a small village of that name. It is of short fiber, weak, and of a foxy color, most objectionable for spinning.

Jute doubtless takes its name from the Sanskrit, as the words "jhont," "jhot," and "jhat" are all derived from the Sanskrit "jhat," meaning "to be entangled." One form of the root is jat, and from it are produced jata and juta, both meaning "matted hair." The name "jute" was first used by Dr. Roxburgh. The Bengal name of the plant is "pat" or

"paat;" the fiber, "jute;" the cloth, "tat chotee" and "megila." The Malays call the plant "rami tsjina," and the Chinese name is "oi-moa," etc.

As to the geographical distribution of jute, *Corchorus capsularis* is cultivated in India, by the Malays, and by the Chinese to a limited extent, and has been introduced into the United States. *C. olitorius*, also cultivated in India, has been naturalized in all parts of the tropics as far north as the shores of the Mediterranean. It is also grown in Egypt and Syria as a pot herb; hence the name Jews' mallow. It should be noted, however, that the commercial fiber known as China jute is not jute at all, but is derived from *Abutilon aricennæ*, a plant which, by the way, is known as a common American weed.

### THE FIBER AND ITS USES.

Were it not for its fineness, silkiness, and adaptability for spinning, with the easy cultivation of the plant, jute would not to-day hold the position it has secured in the industrial economy, for, compared with the other textiles, it is very inferior. Several American plants that are classed as weeds produce better and stronger fiber, but their cultivation and preparation are yet matters of experiment. One defect of jute is the difficulty to spin it into the higher numbers. Its durability is also against it, as the fiber can not stand dampness, and under the best conditions rapidly deteriorates. The bleached fiber also loses its whiteness and in time oxidizes until it presents a dingy, yellowish-brown color. Its strength is inferior to most other fibers, though it is amply strong for the coarse uses to which it is commonly put, such as the manufacture of gunny sacks, cotton bagging, etc., where durability is of less consequence than primary cheapness.

Samples of the fiber exposed for two hours to steam at two atmospheres, followed by boiling in water for three hours, and again steamed for four hours, lost 21.39 per cent by weight, being about three times as great a loss as that suffered by hemp, manila hemp, phormium, or coir. A similar test of jute with flax, hemp, ramie, and other fibers showed as great a loss, while flax lost less than 4 per cent and ramie a small fraction under 1 per cent.

The fiber is employed in three forms of manufacture: Weaving into fine and coarse fabrics, in the making of fine twines and cordage, and in paper manufacture, the latter chiefly from "jute butts and rejections."

In Europe the fiber enters into a great variety of fabrics or cloths, such as curtains and upholstery, carpets, etc., and even sheetings and imitations of silk fabrics. George Watt says that it has been applied extensively as a substitute for hemp. For this purpose the fibers are rendered soft and flexible by being sprinkled with water and oil, in the proportion of 20 tons of water and 2½ tons of train oil to 100 tons of jute. Sprinkled with this the jute is left for twenty-four to forty-eight hours, when, after being squeezed by rollers and hackled, the fibers

become beautifully soft and minutely isolated, and thereby suited for a number of purposes unknown a few years ago. Its perishable nature is fatal to its obtaining a position much higher than it has already attained, and probably admixture of jute in certain articles, such as sailcloths, must sooner or later be viewed as a criminal offense.

In coarser woven goods it appears as webbing, burlap, and cotton bagging stuff. Its use in fine and coarse twines, binding twine, sash cord, etc., is very large, while it is also used extensively in the smaller sizes of rope. Because of its fineness and luster, coupled with its cheapness, it is frequently used to adulterate the manufactures from better fibers, and on account of the tendency to rapid deterioration already noted such use is plainly fraud. When employed in hemp twines in this manner, it is artificially given the dark color of hemp, its natural color being a light salmon. Binding twine is sometimes made of this fiber, colored to resemble hemp, and sold at a good price under a fancy trade name.

## CULTURE IN INDIA.

### KINDS OF SOIL SELECTED.

While jute grows throughout India, the largest areas are doubtless cultivated in Bengal, where there is great diversity in soil and climate, and where the conditions are as varied as in the different sections of the Southern United States. Referring to Bengal, Mr. Kerr tells us in his exhaustive report that the high lands, low lands, recent alluvial formations along rivers (known in India as churs—mud banks and islands), dry lands, humid lands, and even cleared bamboo jungle, have been all more or less cultivated in jute. He, however, classifies these lands under two general heads: First, "Súná," high land, which is generally reserved for the cultivation of fruit trees, pulses, vegetables, tobacco, sugar cane, and early rice; and second, "Sáli," or the low lands upon which the late rice crop is produced. In the interesting reports received from local officers some of the references to the high-land (Súná) cultivation are instructive: In Nuddea "jute is sown on high and dry lands fitted for sowing 'aus paddy'[1] and cereals." In Jessore "the cultivation is carried on on deserted homesteads and pálan lands adjoining a ryot's residence." In Rungpore "low grounds are rejected, because water collects there during the rains, which is prejudicial to the growth of the plant." A Dacca official reports that on the high lands the fiber is shorter and finer. In Sylhet "the quality of jute produced on the 'churs' is comparatively inferior to that produced on 'chora' lands, or the high lands close to homesteads." The Durrung report gives the best selection as "within the homestead land or immediately outside its limit." In Bhaugulpore "the land selected is generally high and rich from its vicinity to the villages." Making comparison of the

[1] "Aus paddy" is rice sown in February or March, to be harvested in August and September.

districts named with those mentioned on another page in connection with the different qualities of jute and where produced, the evidence seems to show that the finest jute is grown upon the high lands. On the other hand, a perusal of the reports from Furreedpore, Pubna, Backergunge, Mymensing, etc., supply evidence in favor of the low lands, though, as the collector of Dacca remarks, "the coarser, heavier jute is grown on the lowish 'chur' lands."

In his summary, Mr. Kerr says:

During the course of our own local inquiries we saw the "churs" on both sides of the rivers Brahmaputra, Teesta, and Lukheea covered all over with extensive fields of jute. The plant also grows luxuriantly in the Sunderbuns, where the land is more or less impregnated with salt; and I have seen jute thrive in the marshes of Furreedpore and Backergunge in waist-deep water. The fact is, the growing demand for the staple has stimulated cultivation to such an extent that, as the collector of Rungpore very justly observes, "it has caused all kinds of soil to be used, independently of their fitness for the cultivation, whenever other circumstances are favorable, and a crop can be anyhow raised." The great bulk of jute that comes from the central and some of the eastern districts is grown on "churs" and on inferior soil, but in the "desi," or the littoral districts, a larger proportion is grown inland than on the banks of the rivers. In the early days of this cultivation, however, when jute was raised for home consumption only, it used to be grown only on raised lands close to the grower's homestead. On the whole, the balance of evidence is decidedly in favor of high or "súná" lands as the best for jute, provided all the other conditions necessary for its healthy growth be attainable, but that low lands and "churs" are not unsuited, "churs" ranking midway between the two.

In the United States lands known as river bottoms might be considered favorable to jute culture, particularly in sections of the South, where are found the proper degrees of heat and moisture, and these situations would approximate to the "churs" of India. While the plant flourishes in India on almost every description of soil except laterite, rich alluvial lands give the best results, particularly in connection with a hot, damp atmosphere and heavy rainfall. A light, sandy soil, however, is not suited to the plant.

In the district of Burdwan the plant is grown on soil composed of rich clay and sand in equal or nearly equal proportions. In Mymensing it grows on "soil consisting of a mixture of clay and sand, or sand combined with alluvial deposit;" in Backergunge, "on loam mixed with a little sand;" in Cooch Behar, "on soil with a certain admixture of sand;" in Tipperah, "on loamy and sandy soil;" in Pubna, "on land which is neither inundated nor dry, the soil being loam, i. e., half clay and half sand." On the other hand, the jute plant appears not to be averse to a clayey soil. It grows in the Barripore subdivision of the Twenty-Four Pergunnahs "on mátiál or clayey soil;" in Hooghly, according to the district officer and Baboo Joykissen Mookerjee, "on clayey soil," which in their opinion is "best suited for jute cultivation;" in Moorshedabad, also on "clayey soil," which is considered there, too, to be "best adapted for jute;" in Noakhally, "on high land, the soil of which is called attáliá," i. e., stiff and sticky; and in Cuttack, "on high land, rich and clayey." It also thrives in ferruginous soil, as

in Bhowal, in the district of Dacca, where jute is pretty largely cultivated; and the fiber produced there is considered to be among the best kinds which find their way to the markets of Dacca and Naraingunge.

George Watt condenses the description of the proper climate for jute into this brief statement:

> A hot, damp climate, in which there is not too much actual rain, especially in the early part of the season, is the most advantageous; in exceptionally dry seasons one frequently finds crops standing through the cold season which the cultivator did not regard as worth cutting down.

But there is a limit to the amount of moisture that the plant can stand, and experience has proved that too much rain at the beginning of the season and early floods are equally destructive to the young plants and injurious to the crop. The most congenial conditions are alternate sunshine and rain, and even excessive rain after the plant has reached a height of several feet is not injurious if water does not lodge at the roots. The effect of such lodgment, or from the plants standing in water, is the growth of suckers, which causes defective fiber. Drought stunts the plant and also injures the fiber. In the preparation of the soil much depends upon its constituents, heavy or clayey lands requiring more plowings than the lighter, sandy, or alluvial lands. In general terms the soil is thoroughly broken up and finely pulverized, and with heavy soils much is accomplished in this direction by the action of the elements—the sun particularly.

### PREPARATION OF THE SOIL.

George Watt states in his reports on Indian fibers that when the crop is to be grown on the low lands, where there is danger of early flooding, the plowing is begun earlier than on the high lands. The preparation, therefore, commences in November or December, some authorities say September, though it may be put off until February and March, and even as late as June. Four to six plowings are usually given, and at the last plowing all weeds and other trash is collected, dried, and burned. It should be noted, in passing, that plowing in India is a very different operation to the breaking up of land in this country, where improved farm implements are everywhere used. Some of the native India plows are rude and primitive affairs. In the Baraset subdivision of the district Twenty-Four Pergunnahs land is sometimes plowed ten or twelve times; a rude harrow made of bamboo, called a ladder, is also used in some districts, and the clods broken with a mattock. The soil for early sown jute is sometimes laid with manure, but this is never the case with the later sown crops. In the Hooghly district fresh earth and cow dung are used for manure, but the poor soils are treated to oil cake. In localities where the ryot is too poor to own a plow and cattle the land is turned with a hoe. As a rule, the oftener and more thoroughly the land is plowed the larger is the yield.

Regarding soil exhaustion and keeping up the fertility of the land, Spon makes the following statements:

Generally speaking, jute exhausts the soil to a much greater extent than other crops. Even virgin land, which has been broken up for a first crop of jute, will, in the second year, lose about 25 per cent of its productive power; and, even though afterwards heavily manured, its yield in the third year will be about one-half of the first year's crop. So that, except in the case of rich low lands flooded annually, it is rare that jute is grown in one field for more than three years consecutively. This exhaustion is remedied by manuring, rotation of crops, and fallows. The manures ordinarily used are cow dung, ashes, house sweepings, oil cake, the ashes of burnt jute roots, the stubble of rice crops. Cattle are often stalled upon the fields. An analysis of the plant would at once indicate what constituents were principally extracted from the soil. All refuse from the plant should be returned to the soil. Rotation of crops is practiced in almost every district where jute is extensively grown, and is well understood by the cultivators, though no universal rules are current. The crops most frequently selected are mustard, rice, and pulses. Leaving the land fallow for two to three years is resorted to whenever found necessary.

### SOWING THE SEED.

The seed for planting is saved from year to year—not purchased in the market—the practice being to allow some of the plants to remain standing until the seed pods are mature. It seems to be the practice in many districts to use the stunted plants, or those unfit for fiber, for this purpose. As a result there is practically no selection of seed in many parts of India, and deterioration must result. In the few districts that are the exception to the rule great care is exercised to secure seed from vigorous plants. After gathering the pods, in September, October, or November, according to time of planting, they are sun dried for four to ten days, then thrashed, gathered, and stored. The manager of the Serajgunge Jute Mills is quoted, in the India report of 1874, as follows:

I have been told that the seed ought not to be allowed to ripen on the plant, but that the top branches, on which the capsules containing the seed grows, ought to be cut at an early period and dipped into hot water for a moment, and then allowed to dry. Seed thus prepared is said to give a far better crop than that allowed to ripen on the stems.

When seed is sold it brings only 2 rupees[1] per maund, or about 91 cents for 82 pounds, though as high as 10 rupees per maund have been paid.

The quantity of seed sown varies greatly in the different districts of Bengal, ranging from 1 seer per bega in Hooghly to $6\frac{1}{2}$[2] seers in Burdwan. This would give in English equivalents $5\frac{1}{2}$ pounds to $11\frac{3}{4}$ pounds per acre. Twelve to 15 pounds to the acre is generally accepted as the average, though Spon states that 22 to 28 pounds is required. The yield of seed per acre in India is about $4\frac{1}{2}$ maunds, or nearly 400 pounds.

[1] The rupee, worth 23.4 cents at the present time, was in 1874 worth 45.8 cents.

[2] A seer is 1 pound 13 ounces. A bega of land in Bengal is about one-third of an acre.

The season for putting the seed into the ground extends from February to June, though March and April are the months usually selected. As in the case of plowing, so in the period of sowing, there are marked differences; but the mode of sowing is with one exception alike everywhere. The seeds are sown broadcast on a clear, sunny day, and covered over with a thin crust of earth, either by the hand, or by a "binda" or harrow, or a "moi" or ladder, or, as in Bhaugulpore and Julpigoree, by beams of wood drawn over the field by oxen. The exception refers to some tracts in the Sylhet district, where sowing is effected in seed beds, and the seedlings are subsequently transplanted in the fields.

On germination, which takes place within three to four days after sowing in Backergunge, Mymensing, and Julpigoree, and seven to eight days in Rajshahye and Luckhimpore, the fields are harrowed or weeded, or subjected to both processes. In Pubna, the field is "weeded once, or at most twice," and the plants are thinned; in Dacca, it is weeded "as often as necessary" after the plant "grows an inch or two high;" in Tipperah, "when the plants are 2 feet high, the weakly ones are removed to thin the field;" in Rajshahye, when the plants are sufficiently high, "say half a cubit or 9 inches high," the field "is well weeded;" in Mymensing, the weeding is done with a "binda" or harrow, but in some parts of the district "a sayin (a kind of scythe with a sharp, convex edge) is used;" in Backergunge, "the field is once weeded on germination, and again sometimes when the plants are 15 to 18 inches in height;" in the Serampore subdivision of Hooghly, "when the plants are about 5 inches high, the field is weeded and thinned;" in Furreedpore, "when the plants are from 4 to 8 feet high, the field is sometimes weeded;" in the Baraset subdivision of the Twenty-Four Pergunnahs the field is harrowed and weeded when the plants are a foot high, and the weeding is done when the plants are 5 or 6 inches high; and the process is repeated twice and even thrice in the Burdwan district. No tending is considered necessary after germination in some parts of Furreedpore, and after the plants are sufficiently grown in the Basirhaut subdivision of the Twenty-Four Pergunnahs. In the Satkheera subdivision of the Twenty-Four Pergunnahs, no weeding is ever resorted to. In other districts the processes of weeding and thinning are carried on in different degrees.

Little or no after cultivation is given, and no care further than to thin out the weaker plants where a field is overcrowded. Ordinarily, the space left between plants is 6 inches, though in some localities more space is left, sometimes 8 to 10 inches. The plants mature in about three months, so that the harvest of a crop sown in March or April will come in June and July, the May and June sowings maturing in September and October.

In harvesting, a bill hook or a sickle is the implement used, and unless there are suckers the plants are cut near the root. In some parts of Furreedpore, as an exception, plants growing in the water or in swampy grounds are pulled, not cut. The proper time for harvesting is when the flowers have put forth and just before the seed make their appearance. Fiber from cuttings at this time is said to be of superior quality, but fiber from plants that have not flowered is weak. On the contrary, plants in seed produce a harsher fiber, though heavier and

stronger, than that from plants cut in flower, and by allowing the seeds to ripen it is said that the weight of the crop will be doubled, though at the expense of good fiber.

After the crop has been collected the plants are in some districts stacked in the field and exposed to the action of the dew and sunshine, till the leaves—which, if steeped along with the stalks, are said to discolor the fiber—have dropped off. In others the leaves are said to add to the weight of the stalks and make them sink readily, and therefore they are not removed. Elsewhere the process of stacking is said to bring on the retting of the bark more quickly, and accordingly the plants, after reaping, are left in the field for two days in Jessore, Burdwan, Hooghly, and Howrah; for two or three days in the Baraset subdivision of the Twenty-Four Pergunnahs, in Julpigoree, Sylhet, and Tirhoot; for three to four days in Cachar, Darjeeling, and in the Serampore subdivision of Hooghly; for five days in Bhaugulpore, and for seven to eight days in the Diamond Harbor subdivision of the Twenty-Four Pergunnahs. But in the great majority of districts stacking is not practiced. The stalks, when cut, are made up into bundles, each of a weight sufficient for one man to carry, and in some places of two sizes, long and short, and in other places of three sizes, long, middling, and short.

This closes the account of the agricultural operations, and the India method of preparing the fiber will be found in its appropriate place in another section.

## CULTURE IN THE UNITED STATES.

The experience in jute culture in this country is limited; nevertheless superb jute has been produced in an experimental way, and as the practice followed in the different sections of the South, in time past, has given very satisfactory results, it may be safely employed in future experiments and in industrial culture. (Pl. III shows the growth of jute at Audubon Park, New Orleans.)

### FAVORABLE SOILS.

A study of the practice in India points to the choice in this country of alluvial lands, such as the second bottoms, so called, along rivers or other bodies of water, and even low lands that are not flooded. The experience of those who made trials of the culture in the early seventies indicates that while the plants will grow on a great variety of soils, the best results are secured where there is plenty of moisture or, when the moisture is not found in the soil, where it can be supplied artificially, as by irrigation.

In the experiments in Florida in 1872 it was proved that on medium grade pine lands the plants dried up, while cultivation in a bay head, composed of muck several feet deep, cleared off and limed, produced

JUTE CULTURE IN LOUISIANA.

stalks to the height of 12 feet or more. On Florida cotton lands, which are not uplands, the plant did well. In Georgia, in the same year, culture on sandy lands resulted in failure, while a crop sown upon "stiff clay lands" produced stalks 15 feet tall. A South Carolina farmer utilized rice lands, securing stalks 7 to 10 feet tall. He advocated alternating with rice, say every two years. In Louisiana several experiments were conducted, the same year, upon river lands 1 foot and 3 feet above gulf tide. Notwithstanding that the season was very dry, stalks 10 to 13 feet tall were produced, and the experiment was considered in every way a success. In North Carolina moist bottom lands were chosen with good results. Doubtless there are thousands of acres of superb natural jute lands in Florida, without considering the reclaimed lands in the southern central portion of the State, which are capable of producing finer jute than is imported into this country. And in Louisiana, and all along the Gulf, as well, it was demonstrated twenty years ago that both on the alluvial lands and in the pine flats, large crops could be produced, as the plants grew in such rank luxuriance. The beautiful specimens of native-grown jute shown in the Department's fiber exhibit at the World's Columbian Exhibition, 1893, were produced near Galveston, Tex., by the Felix Fremerey Decorticator Company, on the irrigated lands of that section.

### PAST EXPERIMENTAL CULTURE.

Professor Waterhouse, of St. Louis, who has written exhaustively upon the subject of jute cultivation in this country, wrote in the annual report of this Department for 1876 as follows:

> Under the auspices of the Department of Agriculture, experiments in the culture of jute have been succesfully tried in South Carolina, Florida, Georgia, Louisiana, and Texas. These trials conclusively establish the fact that wherever in the Southern States there is a hot, damp climate and a moist soil of sandy clay or alluvial mold, jute can be profitably raised. It is probable that much of the land now devoted to the growth of cotton, rice, and sugar cane, would yield larger returns if applied to the culture of jute.

Prices of the fiber have lowered considerably in the past twenty years, but the fact of successful cultivation in the sections named is indisputable, however the question of competition with India, at the present prices of the cheaper grades of jute, remains to be settled.

Mr. Emile Lefranc, writing upon this subject in 1873, said:

> To obtain good fiber crops the land must be elevated, rich, moist, and well drained, as in India; to raise seed, low lands may be used, provided that favorable weather allows sowing and enables the growing plants to keep above the points of overflow. However, when the growth is fully started water is not to be feared so long as the tips remain above the surface of submersion. In the first case jute is sown broadcast; in the second, in drills 5 feet apart. That interval is to facilitate the branching, and, at the same time, the destruction, by plowing, of the tall weeds which generally occupy low lands. In both methods the soil must be plowed as deep as possible in January or February, then left exposed to atmospherical influences until the planting period. That period commences with April and terminates with June, in monthly

succession. To prepare for sowing a second plowing is required, and as fine a harrowing as can be effected. The "circular pulverizer," applied before the harrow, shortens the labor. Then the sowing for fiber crop is performed broadcast with a Calhoun sower. With that instrument, costing $8 or $10, a man can sow 10 acres of jute per day. The quantity of seed required for each acre is from 12 to 15 pounds.

The ground being well tilled and the seed properly sown, on wet days, if possible, the jute is left alone like wheat. No other care than that of drainage is necessary until maturity. In the bottoms when we plant in drills for seed, a subsequent plowing or two will be necessary in the intervals to neutralize the encroachments of grass. In Louisiana this labor is a necessity, principally for the purpose of combating the tall weed called "wild indigo," which occupies the lower grounds. This tall weed, which is also fibrous, is the only vegetable that keeps pace in growth with jute; all other plants are distanced and smothered by its shade.

Mr. Felix Fremerey, who has had considerable experience with this culture, both in Louisiana and in Texas, has furnished the Department the following statement relative to the practice on the irrigated lands of the latter State. He says:

In February the soil is plowed to a depth of 7 inches and exposed to the influences of sun and air. By the middle of April, when the soil has gotten fairly warm, and by no means before, it is harrowed twice in order to thoroughly pulverize it. Furrows at a distance of 8 inches are drawn by means of a drill; they should be about 2½ to 3 inches deep, and cotton-seed meal at the rate of a quarter to half a ton per acre is thrown in them. The seeds are dropped in these furrows at the rate of 15 to 16 pounds per acre and then covered with earth in any convenient manner. At this time of the year the soil contains much moisture, which, combined with the atmospheric warmth, brings the seeds to germination in a few days; the young plants will appear about the fourth or fifth day after sowing, when they will rapidly advance in growing, requiring no care whatever. As long as there is sufficient moisture in the soil the plant should be let alone, but as soon as the ground begins to be dry irrigation should be resorted to. In order to insure a most regular and effective soaking of the soil, I would advise to draw furrows in both directions about 4 inches wide, and as deep, at regular distances of 10 or 12 feet. If the soil is naturally rich no fertilizing in connection with irrigation is required; in the case, however, of the soil being poor, or humus being insufficiently represented in it, additional fertilizing should be given, and for this purpose I would advise to put in cotton-seed meal, mixed with water, a few days before its use; the meal will rot and the irrigation water will carry it where it will become available for the young plants. A jute plantation must be kept moist, avoiding an excess of irrigation in order to keep the ground as far as possible in a temperate warmth. If the plant has attained the age of four weeks its rank growth will prevent the sunbeams from penetrating to the soil, so it will for a long time preserve the needed moisture and consequently keep the soil soft and mellow, allowing the roots to absorb the needed chemical constituents, and permitting organic and mineral plant food to decompose so as to render them fit to be drunk by the plants. In case of broadcast sowing, 22 to 25 pounds of seed should be used, waiting if possible until after a rain; or if natural precipitation is lacking, after a soaking of the soil by irrigation. The manure in this case should be spread as uniformly as possible before harrowing, and after sowing the soil should be smoothed by a common field roller in order to press the seeds in the ground, granting them in this way every chance of germination.

### POSSIBLE YIELD IN THE UNITED STATES.

Warden, in his work on the linen trade, 1867, places the yield of jute fiber per acre in India at 400 to 700 pounds. George Watt states in the report of the revenue and agricultural department of India

(1888–89) that an average crop of fiber is 15 maunds,[1] though the range is from 3 to 36 maunds per acre. He also cites the experiments performed at the Saidapet farm in Madras, where the yield was 599 pounds of fiber if cut close to the ground, and 703 pounds when pulled, but adds that this is less than half of the average yield in Bengal.

In the reports of experiments with the seed sent out by this Department in 1870 various estimates of yield are returned, based on the production of small areas, it is true, in which yields of 3,000 to 4,000 pounds per acre are named. Mr. Fremerey writes the Department that 3,000 to 6,000 pounds per acre can be assured, though he bases his figures not on actual yield, but on an estimate of the amount of fiber to be obtained from a crop of 300,000 stalks to the acre.

Undoubtedly the American yield, on proper soils, will be considerably higher than the yield in India for several reasons: With our improved agricultural implements the ground can be better prepared, giving a more luxuriant growth; the soils are richer, and an American farmer would always secure seed for the next year's sowing from the healthiest plants, and not from the poorest, as is the practice in India, so there would be gradual improvement instead of deterioration. It would be perfectly safe, then, to count upon crops of 3,000 pounds per acre, since this yield is exceeded in India under the best conditions of growth.

So much has been said in the section on India culture regarding the proper time to harvest the plant, that the directions need not be repeated here. Mr. Fremerey writes that the crop matures in Texas in seventy to one hundred days, and that the cutting can be accomplished with a sickle, scythe, or a mowing machine, though care should be exercised to lay the stalks parallel in order to avoid unnecessary labor in the after handling.

Mr. Fremerey's figures of yield, before referred to, are as follows:

An acre of jute averages 350,000 to 360,000 stalks per acre. With a reasonable estimate of 300,000 stalks to the acre, 100 stalks 9 feet in height will yield 1 pound of fiber, or a total of 3,000 pounds for the entire area, a stalk 10 or 12 feet long giving a proportionately larger yield.

## EXTRACTION OF THE FIBER.

### EXPERIENCE IN INDIA.

In India the fiber is separated from the stalks by retting or steeping for a week or more in water. From Mr. Kerr's report we learn that the almost universal practice is to ret in stagnant water, "especially such as contains a large proportion of decomposing vegetation," which expedites the retting process. It is stated, further, that the ryots go down into the pools and, standing waist deep, thrash the water with handfuls of the retted stalks to facilitate the separation of the fiber.

In steeping the stalks in water they are covered with a layer of refuse tops of the jute plants or other jungle plants or with clods of earth, sometimes with cow dung,

[1] A maund is 87⅔ pounds.

sometimes with the trunks of plantain trees, or logs of the date tree, and sometimes with straw smeared with mud. This is done partly with a view to protect the upper parts of the bundles from the action of the sun, and partly to keep the stalks sufficiently below the surface of the water, and also, it is believed, to hasten the process of retting. In some places the bundles are at first sunk by the root end, which is harder, leaving the upper end exposed above the water, and then after ten or twelve days the upper end is pressed down to the same level with the root ends, so that the whole length of the stalks may ret uniformly. In other places the bundles are turned over while steeping. In Dinagepore is found a singularly exceptional variation in one part of this process, mentioned by Baboo Khetter Mohun Sing, the manager of the Dinagepore rajah's estates. He says: "After the plants are cut and the leaves shaken off they are collected into bundles and a mixture of dung and water being besprinkled over them they are kept afloat for three days on the surface of the water." This peculiarity is noted both because Dinagepore is the second largest jute-growing district in this province and because Baboo Khetter Mohun Sing, from his special local opportunities, must have observed what he describes. There is, however, no mention of it in the district officer's report, nor the remotest allusion to it either in the reports from other districts or in the evidence of the agriculturists consulted by the commission.

While the bundles are under water they are examined from time to time to test how far the retting has progressed, and when the retting has so far gone on that the fibers peel off readily the bundles are taken out of the water and at once put in hand for the separation of the fiber, according to the several methods prevailing in the different districts. In Singbhoom, Tirhoot, and Balasore, however, the stalks are first dried in the sun and then subjected to the next process. The process of separation most generally followed is to beat or shake the stalks in the water in which it is steeped till the glutinous substance in the bark is entirely washed away. The stalk is held indifferently, either by the top or the butt end. The fibers at first detach partially from the pulp, but by continued agitation in the water gradually disintegrate from it altogether.

Another account, by a merchant of Calcutta, in a letter to Dr. Royle, is as follows:

The proper point being attained, the native operator, standing up to his middle in water, takes as many of the sticks in his hands as he can grasp, and removing a small portion of the bark from the ends next the roots, and grasping them together, he strips off the whole with a little management, from end to end, without breaking either stem or fiber. Having prepared a certain quantity into this half state, he next proceeds to wash it off. This is done by taking a large handful; swinging it round his head he dashes it repeatedly against the surface of the water, drawing it through toward him, so as to wash off the impurities; then, with a dexterous throw he fans it out on the surface of the water, and carefully picks off all remaining black spots. It is now wrung out so as to remove as much water as possible, and then hung up on lines prepared on the spot, to dry in the sun.

### PRACTICE IN THE UNITED STATES.

Half a dozen pages might be given showing the variations of this operation in different districts, but they all amount to practically the same thing. In reviewing the India practice my purpose is not to recommend it, as few American farm laborers North or South could be found who would adopt it any more than European laborers will pull flax by hand after becoming residents of the United States, if they can avoid it.

Plainly, then, successful jute culture in the United States can only be brought about by the use of machinery for extracting the fiber, and my statements made in a former report on the subject of bast fibers in general may be repeated here:

> The first thing to be considered, however, is the question of economical production. What will it cost to grow an acre of stalks, and what will be the expense of stripping and cleaning the fiber? Until these questions can be satisfactorily answered, the cultivation of the fiber must be considered as still in the experimental stage, and it would be unwise to go into the culture expecting sure remuneration. The machine question, as stated, is an important factor in the problem. The hand methods in vogue in many foreign countries where such fibers have been successfully produced are unsuited to the progressive ideas and spirit of enterprise which underlie all American agricultural and industrial practice. This suggests the use of machinery at least for stripping the bark from the stalks, the fiber to be cleaned and prepared by after processes which, however, do not concern the grower. The bast of hemp has been stripped from the stalk for a hundred years by means of a cumbersome hand brake, the fiber being first softened by some form of retting. With the advent of a satisfactory hemp brake, we shall doubtless have a machine that will decorticate all of these so-called hemp and jute substitutes.

### THE MACHINE QUESTION.

Many machines have been invented in past years which for one reason or another have been found impracticable. Some have possessed merit, and a few have shown promise, when further improved, of giving full satisfaction. It should be noted that in referring to such machines we are not considering those for decorticating or defibrating ramie, though the successful ramie machine, when it appears, doubtless may be used as successfully, with slight modifications, for cleaning bast fibers in general. The machine question, as regards hemp and the hemp and jute substitutes, may not be regarded, therefore, as an immovable stumbling-block in the way of utilizing these fibers economically, for the efforts of American inventive genius must in time be crowned with full success.

As long ago as 1872, Mr. Lefranc considered the machine question settled for the decortication of both ramie and jute, yet the jute industry did not materialize at that time, nor even at a period twelve to fifteen years later, when the promoters of another machine were able to induce many Southern farmers to go into jute culture, with the promise of a satisfactory device for putting the crop into marketable condition. At the official machine trials of 1892, Mr. Fremerey entered a decorticator, which, with four attendants (and after making an allowance of eighteen minutes' time lost in adjusting the machine), stripped 37¾ pounds of wet ribbons from 100 pounds of jute stalks in thirteen minutes of actual running. This meant that if the machine had run continuously all day at this rate, 4,615 pounds of stalks would have been cleaned, yielding 1,680 pounds of wet fiber, which, after drying, would have given one-third to one-half of that weight. Nevertheless, with such a machine, were a farmer to employ otherwise unoccupied time in the work of decortication, he would be able to take care of the crop

of a few acres. This machine was used for saving the crop in the Texas experiment a few years ago, and I am informed has since been improved.[1]

There are no such obstacles to the successful decortication of jute by machinery as have confronted the experimenters with the devices for cleaning ramie, and it would seem that a suitable machine could be cheaply constructed.

But the machine alone does not prepare the fiber in marketable form. The decorticated ribbons have yet to be retted to remove the gums, wood, and other waste matters, and give a spinnable product. The best combined process so far available is to strip the stalks by machine and ret the fiber in tanks of water. Mr. Fremerey, who has had large experience in this work, recommends the use of wooden vats filled with water and kept as near a temperature of 95 to 100° F. as possible; or holes may be dug in the ground, as for flax retting, measuring, say, 10 feet long by 4 wide and 4 feet deep. The stripped ribbons are tied loosely in bundles of about 50 pounds, for ease in handling, and placed in the vats or pools in such a manner as to insure their being completely submerged. Mr. Fremerey says:

> The water in such tanks before beginning action on the "pectose" must reach a certain degree of acidity; it is therefore important to assist nature by putting in the water small quantities of sugar, molasses, bran of any grain, vinegar etc., which, under the influence of moderate warmth, will induce fermentation. It has been asserted that the jute bark possesses a tough outside coating, but the inside of the bark, of which all ligneous matter should be peeled off by the decorticator, is very soft and tender; it is at that point that fermentation or transformation of the pectous substances into soluble pectic acid sets in, and in its action it is so rapid that the coloring matters are completely destroyed in a very short time, thus preventing them from discoloring the fibrous material. The fermentation is accomplished in some five to eight days, thus mostly depending upon the degree of warmth in the atmosphere, when the fibers are taken out, rinsed in clear water, and put to dry on ropes or galvanized wire in the sun or under shelter, where wind has free access.

Where a machine is not available—and the Department can not be understood as authoritatively recommending any machine in the absence of recent official tests—a modification of foreign practices must be resorted to, or the retting process employed by Mr. Fremerey may be utilized, by putting in the stalks in bundles, and keeping them submerged until the dissolution of the gums and waste matters has been accomplished. In the absence of the vats or pools, the India practice of retting in pools or waterways must be followed, though it is not essential that the farmer shall follow the Indian royt's example, by taking a warm bath in water fouled by decomposing vegetable matters almost to the point of putrification.

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[1] In a recent letter from Mr. C. E. Angell, formerly of Galveston, Tex., but now of New Orleans, he states that he has just shipped a six-knife Fremerey machine to Calcutta for trial.

It is doubtful, however, if the industry could be made to pay as an isolated industry with only moderate areas under cultivation. The small farmer might be able to care for a few acres in time not otherwise employed, and thus add a few dollars to his income, provided that other farmers near him also produced a little. In this manner a community might grow enough jute fiber in the aggregate to attract buyers, just as in some foreign flax centers a large part of the product of a commune is made up of the "littles" produced on peasant farms. This is not in accordance with American ideas of farming, however, and therefore, if the tiller of moderate areas should be unable to make jute culture pay, allowing a fair return for his labor, the culture must be established on a 500-acre scale, as recommended for the economical production of sisal hemp in Florida.

But as the Southern farmer does not always gin his own cotton—and cotton gin plants are found in every community—were jute culture to become a Southern industry the managers of gins might also undertake the business of stripping and retting the jute crop, provided, however, that no large expense was entailed by long hauls in transportation. The perfectly satisfactory machine for stripping the ribbons of bark from the stalks will undoubtedly be one that can be operated in the field.

Comparing this culture with that of cotton, nearly fifteen years ago Professor Waterhouse made the following statement:

> The raising of cotton is laborious and costly. From the turning of the furrow to the completion of the harvest unremitting care is necessary to insure a plentiful crop. But the tillage of jute is easy and inexpensive. The operations after the stalks have been gathered require the greatest work and outlay. This difference increases the probability of success in the attempt to raise jute in the United States, for a large part of the toil expended upon the culture of cotton is necessarily manual. But a great portion of the work which prepares jute for the market can be performed by mechanical processes.[1]

It is hardly to be expected, however, that jute culture will ever supersede cotton culture as a Southern staple. It would occupy the place of an auxiliary crop, and to that extent become a factor in the greatly to be desired diversification of Southern agriculture.

## VALUE OF THE CROP.

A perusal of the past literature of the subject published in this country reveals promises of large remuneration to those who will embark in the industry. Tables showing cost of production and profits of culture have appeared that, however honestly they may have been stated at the time they were prepared, are now misleading, for the reason that the prices of fibers of all kinds were never lower than at the present time.

[1] At the time this statement was prepared it was supposed that the question of cheap decortication had been settled.

The following table showing the values of India jute on December 31, for three years, from monthly statements of H. H. Crocker & Co., New York City, January 1, 1896, is interesting:

| Years. | Jute fiber. | | Butts and rejections. | |
|---|---|---|---|---|
| | Spot. | Shipment. | Spot. | Shipment. |
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| 1893 | 3¼ @ 4½ | 3¼ @ 4½ | 1⅝ @ 2¾ | 1.7 @ 2⅞ |
| 1894 | 2½ @ 3⅜ | 2 @ 3⅜ | 1¼ | 1 1/16 @ 1⅝ |
| 1895 | 2⅜ @ 3¼ | 2¼ @ 3⅜ | 1⅛ | 1 1/16 @ 1¾ |

Turning to the report on the Foreign Commerce and Navigation of the United States for the year ending June 30, 1895, we find that the fiber was imported in the following quantities:

| Years. | Jute fiber. | | Butts and rejections. | |
|---|---|---|---|---|
| | Tons. | Value. | Tons. | Value. |
| 1894 | 18,154 | $935,537 | 31,845 | $780,821 |
| 1895 | 41,787 | 1,573,690 | 68,885 | 1,181,439 |
| Total | 59,941 | 2,509,227 | 100,730 | 1,962,260 |

These figures show that over 100,000 tons of the cheaper fiber (selling at an average of less than 1½ cents per pound) are used in this country annually, against about 60,000 tons of the fiber, bringing at highest market prices 3⅜ cents a pound. The cheaper fiber is largely used in the manufacture of bagging, with which the cotton crop of the South, in past time, at least, has been baled. It is extremely doubtful if the demand for cheap jute could be met by the Southern farmers at present prices, even if the cotton crop should continue to be baled with jute bagging, and the new inventions for compressed bales covered with iron suggest a contingency worth considering.

The Southern jute planter, then, could only endeavor to fill the demand for the higher priced fiber at the best prices he would be able to realize in competition with the Indian product. That he would be able to secure the full price of the foreign commodity, judging from samples of American jute I have examined, there is little doubt; and were he to grow a superior product, which he would be able to do with better practices in culture than are followed in India, he can fill a limited demand for fiber at higher prices than the Indian product, for use in superior grades of jute manufactures. In time special uses in manufacture might be created that would be filled exclusively by American jute, but this can not be assured.

No attempt will be made to give statistics showing cost of production, for it is not believed that figures based on actual experience with a commercial area in this country can be produced. "Intelligent estimates" doubtless can be made, but where the margin of profit is so

narrow, considering the low prices of the imported fiber, a mere estimate is untrustworthy and misleading.

It is the hope of the Department that careful experiments in this culture will be attempted and efforts made to extract the fiber, in order that the question of economical production of jute in the United States may be practically settled. Past experimentation has demonstrated that the plants will grow luxuriantly in many portions of the South, and that the bark contains a fine quality of fiber. To ascertain the cost of growing the crop and extracting and baling the fiber ready for the market is the only problem to be worked out.